Section 6 Ground Water Protection[1]

i. Summary of Final Decision and Rationale for Compliance Location

EPA presented four alternatives for comment prior to determining the compliance location for the ground-water standards [see the preamble to the proposed regulation (64 *FR* 47000-47004)]. These four alternatives correspond to downgradient distances of approximately 5, 18, 20 and 30 km from the repository footprint. Alternatives related to the 5 and 18 km distances also incorporate the concept of a controlled area, with the former adopting the definition of controlled area as it appeared in 40 CFR 191.12 while the latter represents a combination of the 40 CFR 191.12 definition of controlled area and the contiguous area within the boundary of the adjacent Nevada Test Site. The alternatives related to 20 and 30 km are essentially designated areas at specified distances from the repository footprint. We received numerous public comments on the appropriate distance for the point of compliance (see Issues H and I below), but did not receive

[1] All acronyms are defined in Appendix B.

comments that specifically addressed the use of the controlled area in determining compliance with the ground-water standards.

After reviewing and evaluating the public comments, various precedents, and NAS's recommendations, EPA adopted the concept of a controlled area as an essential precondition to assessing compliance with the ground-water standards. We chose to set a maximum size limit for the controlled area, while also specifying the maximum distance the controlled area may extend from the repository footprint. We have also defined a representative volume for use in calculating radionuclide concentrations in ground water at the controlled area boundary, for comparison with the regulatory limit during the compliance period (10,000 years). The accessible environment includes any location outside the controlled area. The controlled area is limited to 300 km^2 in area and may extend no farther than 5 km in any direction from the repository footprint, except that in the direction of ground-water migration, the controlled area may extend no farther than any point on a line described by 36 degrees, 40 minutes, 13.6661 seconds north latitude. This latter distance is roughly 18 km from the repository footprint. The southwesternmost corner of the NTS and its southern boundary correspond to this latitude designation (Docket A-95-12, Item V-A-29). As a part of the licensing process, DOE and NRC must agree on the specific shape of the controlled area. Two purposes are served by the controlled area. First, it serves to encompass that geology dedicated to the natural barrier portion of the repository system, and thereby serves as a compliance measure by identifying the location where the standards are to be met. Second, the controlled area is used to limit access around the repository site during the period of institutional control.

EPA's mandate through the EnPA is to develop a site-specific standard for the Yucca Mountain site. In doing this, we have used radiation protection principles and approaches we have used in the past if they are appropriate for the Yucca Mountain repository setting, as described in the rule's preamble and in this document. The concept of a controlled area is embodied in the radiation protection approaches we incorporated into the generic rule, 40 CFR part 191, and we believe the concept is appropriate for the Yucca Mountain setting as well – to protect individuals from inadvertent exposures and to define the limits of the natural barrier system dedicated to waste isolation. In the proposed rule, we proposed for comment alternatives for ground-water compliance demonstrations that involved controlled area variations (proposed §197.12). In defining the controlled area for the final Yucca Mountain rule, we have been primarily concerned with its functions as a regulatory compliance measure and as an institutional control for access restriction. We also considered information on the projected behavior of the disposal system in framing the controlled area, since the unique aspects of the repository design play a role in determining the magnitude and direction of potential radionuclide releases into the natural barrier system and the potential exposures from these releases. The potential variations in repository performance provide insight for our determination of an appropriate upper bound to the controlled area for the site that will provide protection from inadvertent exposures from human activities within it that could lead to unacceptable exposures (such as tapping ground water for drinking water or other uses that could give unacceptable radiation exposures). These considerations directed us to examine three types of information about the Yucca Mountain repository setting: information about potential repository design lay-outs (since potential releases could come from any point in the repository); the uncertainty in ground-water flow paths from the repository location to the compliance point - since ground water would transport released radionuclides; and the magnitude of potential releases during the regulatory time period.

In EPA's effort to determine an appropriate site-specific limit on the size of the controlled area, we examined the same type of information that DOE will have to use in proposing an actual size and shape of the controlled area for licensing review. Since the dominant pathway for exposures from repository releases is through the ground water, we examined information about the potential ground-water flow paths from the repository to the farthest extent of the controlled area. This information is summarized in the BID (Chapter 7 and Appendix VI) and also presented in the DOE/VA (Docket A-95-12, Item V-A-5), the DEIS for the Yucca Mountain site (Docket A-95-12, Item V-A-4), and the recently completed Yucca Mountain Science and Engineering Report (Docket A-95-12, Item V-A-27). This information reveals that radionuclides released into the repository unsaturated zone will migrate with ground waters traversing the repository level in a generally vertically downward movement, through the matrix porosity of the tuff rocks and along the generally vertical fractures that exist in these rocks. When the ground waters reach contacts between the tuff rock units, some of the ground water will be diverted in an easterly direction along the slightly tilted tuff rock unit contacts until the waters either encounter open fractures or are absorbed into the porosity of the underlying rock unit. In either case, the generally vertical movement continues until the next rock unit contact is encountered. In this way, the movement of potentially contaminated ground waters through the unsaturated zone is vertically downward with some degree of easterly displacement. When the migrating ground water enters the saturated zone, it joins the general flow direction (generally to the south of the site) and moves toward the border of the controlled area. From examination of Figure 3-67 in the DOE/VA (Docket A-95-12, Item V-A-5), it can be seen that the total extent of easterly displacement of ground water moving through the repository level and into the saturated zone is about 5-6 km from the repository location. However this particular representation of the ground-water movement is not the only possible interpretation. A more direct southerly path from the repository location can also be supported by available data and modeling results (BID, Appendix VI). Therefore the uncertainty in ground-water flow directions leads to an envelope of potential flow paths around the repository layout. The envelope extends directly south of the repository in the direction of ground-water flow and east for a distance of 5-6 km from the easternmost limit of the repository layout. Ground waters in the saturated zone within this envelope could potentially contain radionuclides released from the repository.

The second area of information EPA considered was the potential size and shape of the repository layout. The repository size is a function to two considerations; the total inventory of wastes to be emplaced in the repository and the thermal loading strategy adopted by DOE for the final repository design carried into the licensing process. Because the repository design is not yet finalized, there is uncertainty about the exact repository layout. However, DOE has presented information in the Yucca Mountain DEIS document in sufficient detail to allow a good estimation to be made of possible variations. In Appendix I of the DEIS (Docket A-95-12, Item V-A-4), repository layouts are presented for several thermal loading variations for the inventory considered in the DOE Viability Assessment, along with layouts for some expanded inventory options.

This information coupled with the envelope of ground-water flow paths from the repository, as discussed above, allowed us to estimate the potential size of areas that could potentially contain contaminated ground waters from repository releases. These areas vary from less than 100 km^2 for the smallest repository layout and assuming the ground-water flow is either in the easterly then southerly direction or the southerly direction alone; to areas of approximately 300 km^2 based on the larger repository layout options and assumptions that contaminated ground water could equally well move easterly or directly to the south from the repository.

The final element of EPA's assessments involved examining the potential magnitude of radionuclide releases from the repository. The magnitude of releases would determine whether contaminant concentrations in ground waters could exceed the regulatory limits when these waters reach the boundary of the controlled area. For low levels of releases, mixing of contaminated ground water with uncontaminated ground waters along the flow path could result in concentrations that do not exceed the regulatory limits. In contrast, higher levels of releases could exceed the limits and therefore expectations of the engineered barrier performance play a role in defining a controlled area.

DOE's assessments of repository engineered barrier performance for actual repository designs were first reported in the DOE/VA (Docket A-95-12, Item V-A-5). External review of the assessments pointed out a number of uncertainties DOE had not addressed, which prompted DOE to initiate a repository design review that ultimately resulted in the adoption of a new enhanced design (the EDA II design) that offers considerably longer waste package containment lifetimes under expected conditions. The containment lifetime of the waste packages in the new design are well in excess of 10,000 years and are estimated to be in the many tens of thousands to over 100,000 years (Docket A-95-12, Item V-A-24, and Docket A-95-12, Item V-A-27). Such waste package lifetimes suggest that a small controlled area is sufficient since releases under anticipated conditions would be very low. However, these estimates are not the entire picture of possible releases from the repository.

Even though waste package lifetime under expected conditions (the very slow degradation of the engineered barrier system) is very long, a small number of waste packages would be anticipated to fail from undetected manufacturing defects. Typically such failures would occur from the failure of improperly made welds, and these premature failures (often referred to as juvenile failures) could allow ground waters entering the emplacement drifts to enter the waste package through the failed welds (see Section 4.2.4.3.1 of the Yucca Mountain Science and Engineering Report, Docket A-95-12, Item V-A-27 for an extensive discussion of premature failure mechanisms evaluated by DOE). Although these premature failures can and will be minimized through the application of strict quality control measures during the manufacturing process, it is not possible to completely eliminate them. Therefore, although the performance of the new waste package design is anticipated to contain radionuclides for very long time frames under expected conditions, premature failures to some degree are unavoidable and these releases are of concern in defining a controlled area around the repository. The important point in this regard is that the timing and location of these premature failures within the repository cannot be predicted with high confidence.

They could occur anywhere and could be separated in time or occur relatively close together in time. The magnitude of releases from a prematurely failed waste package, and the resulting contaminant concentrations in ground waters moving through the disposal system, is dependent on many assumptions about radionuclide release mechanisms and subsequent mixing with surrounding ground waters. For assumptions that involve maximum potential releases from the waste package and minimum dilution of the contamination through the ground-water flow path, narrow contamination plumes of relatively high concentration could move through the flow system. Remembering that one function of a controlled area is to restrict access to an area of potential contamination so that human activities do not result in inadvertent exposures, the prudent choice in framing the controlled area would be to include all potential ground-water flow paths within its boundaries. Since the location of the premature failures cannot be reliably predicted, the maximum size of a controlled area would be determined by repository layouts and the envelope of flow paths. It is important to note that by this reasoning, it should not be assumed that the land within the controlled area will be contaminated in its entirety. The premature failure scenario would generate a small number of potentially narrow contamination plumes that may or may not exceed the regulatory limits depending on the assumptions for waste package and subsequent transport in the ground-water system. EPA has placed an upper bound on the size of the controlled area as a conservative safety precaution to assure that the controlled area would not contain any narrow high-concentration plumes that may be possible. A more detailed analysis of the factors that would be used to define a controlled area is given in Docket A-95-12, Item V-B-7.

DOE will have to define the size and shape of the controlled area when it presents its compliance case to NRC in the licensing process. EPA's rule provides for an upper bound on the size of the controlled area, but does not mandate that an area of that size must be assumed. DOE may propose a smaller controlled area based on its analyses of repository performance, including potential releases from juvenile waste package failures, or any other type of failure it proposes (see Docket A-95-12, Item V-A-7), and its assessments of other engineered barriers and the ground-water system at the site. Because the Yucca Mountain site characterization and repository design efforts are still in progress, we believe it is not possible for us to define the size of the controlled area more precisely. In addition, we do not believe we should constrain the repository development effort by defining a controlled area more specifically. We believe that DOE should design an optimum disposal system consistent with the inherent characteristics and uncertainties of the site, and that it is NRC's responsibility to critically review DOE's analyses.

The protection of ground-water resources has been one of EPA's most important priorities, Agency-wide, for many years. In establishing the size of the controlled area and its maximum distance in the predominant direction of ground-water flow, we tried both to follow long-standing Agency policy regarding the protection of ground-water resources and to account for the unique characteristics of the Yucca Mountain site. Please see Section III.B.4 ("How Does Our Rule Protect Ground Water?") of the preamble to our final standards for a full discussion of our ground-water policy, our reasons for including a separate ground-water protection standard in our standards for Yucca Mountain, and a more complete discussion of the rationale for the controlled area.

Issue A: Ground-water protection standards should apply to the proposed Yucca Mountain repository.

1. Given that the ground-water pathway is likely to be a major source of radiation exposure, inclusion of a separate ground-water protection standard is necessary and appropriate. (7, 26, 67, 54, 83, 141, 142, 205, 291, 405, 428)

2. The ground-water protection standard should provide protections equivalent to, or better, than those presently in effect for public water systems under the purview of the Safe Drinking Water Act. (25, 59, 88, 120, 129, 178, 194, 295, 306, 342, 356, 390, 428, 444, 529)

3. [By applying for only 10,000 years] EPA's current proposed standards deviate substantially from the requirements of the SDWA - at the peak dose, EPA's repository standards would permit contaminant levels 350 to 2,300 times the SDWA standards. (444)

4. Ground-water protection provisions are needed to protect the scarce ground-water resources in the vicinity of Yucca Mountain for future generations. Future water users should not have to clean up the ground water before it can serve as drinking water. (50, 67, 73, 205, 390, 481)

5. Extensive underground nuclear testing at the Nevada Test Site has left behind vast number of large-scale source terms containing long-lived, radionuclides. Indeed, the presence of other major source[s] in the area is one reason that a separate groundwater standard is so important. These source terms must be incorporated into EPA's analysis. (136, 295, 445)

6. The citizens of Nevada near Yucca Mountain should have their ground water protected to levels at least equivalent to the protections afforded ground water near the Waste Isolation Pilot Plant in New Mexico, a deep geologic repository for defense transuranic waste. (129, 178, 306, 424)

7. If the repository should survive the environmental review and licensing process, the application of a groundwater compliance standard to the repository should be accompanied by the development of an array of monitoring wells at the periphery of the site extending into the Lower Carbonate Aquifer. Such a system should be designed to determine whether the repository is in compliance with its design standard to provide early warning of contamination and to augment the data requirements for the repository modeling of groundwater flow and contaminant transport. (133)

Response to Issue A:

The purpose of the ground-water standard is to maintain and protect the significant ground-water natural resource in the vicinity of Yucca Mountain. Ground water is one of our nation's most precious natural resources because of its many uses. This is especially true in the vicinity of Yucca Mountain, where ground water is currently used as drinking water, as a resource to support a diverse agricultural economy, and as an ecological habitat supporting sensitive ecosystems.

In general, ground water is a valuable resource with many potential uses. EPA believes that ground-water resources should be protected according to their use, value and vulnerability to contamination. In the case of Yucca Mountain, water from the aquifers that flow beneath the proposed repository is currently used both as a source of drinking water and for a variety of domestic and agricultural purposes 20 to 30 km south of Yucca Mountain. These ground-water resources also supply water for a variety of agricultural activities in the Amargosa Valley, such as crop irrigation, dairy farming, and other domestic purposes (showering, cooking). These aquifers also have the potential to serve a substantially larger population than that presently in the area (NAS Report, p. 92). Moreover, while the individual-protection standard limits total human radiation exposures, including drinking water and non-drinking water exposures, the IPS addresses resource protection less effectively. EPA believes that the ground-water protection standards will provide adequate protection from all potential uses of the ground-water resource that could lead to exposures by limiting the contamination of ground water that would discharge to the surface, such as springs or seep areas. These purposes for the ground-water protection standard are consistent with EPA's longstanding policy for ground-water protection, as set forth in "Protecting the Nation's Ground-Water: EPA's Strategy for the 1990s" (EPA 21Z-1020, July 1991, Docket A-95-12, Item II-A-3).

EPA began developing its ground-water strategy in the early 1980s at a time when we had received numerous Congressional mandates to protect human health and the environment, such as the SDWA, RCRA, and Superfund, among others. It soon became clear that ground-water protection was an integral part of each of these mandates, and that we needed to have a more consistent approach. In August 1984, the Agency's Office of Ground-Water Protection published its "Ground-Water Protection Strategy" (Docket A-95-12, Item II-A-13), which provided overall direction for our ground-water protection efforts. In addition to addressing internal resources and our relationship with external institutions, the 1984 strategy advised protecting ground water according to its use, value, and vulnerability to contamination. Although this strategy was a valuable first step, it became apparent that more specific guidance would be more useful. EPA subsequently established a ground-water task force to address comprehensive protection of the ground-water resource. EPA actively sought participation of interested stakeholders and the public, and extensive input was provided by state and local governments, other Federal agencies, environmentalists, industry and public interest groups. In July 1991, EPA issued "Protecting the Nation's Ground-Water", the purpose of which was to guide future EPA and State activities in ground-water protection and cleanup. Our policies, programs, and resource allocations reflect this approach. The key element of our Strategy is the overall goal of preventing adverse effects upon human health and the environment by protecting the environmental integrity of the Nation's ground-water resources. We believe that it is important to protect ground water to ensure that the Nation's currently used and potential sources of drinking water are preserved for present and future generations.

In carrying out the policies set forth in Protecting the Nation's Ground-Water, EPA typically uses the MCLs, established under the SDWA, as important reference points when the ground water in question is a current or potential source of drinking water. The MCLs are health-based limitations that serve to define drinking water that is safe to drink. Thus, we use the MCLs to protect ground water in numerous regulatory programs where ground-water contamination is a significant possibility. This approach is reflected by our regulations pertaining to hazardous waste disposal (40 CFR part 264), municipal waste disposal (40 CFR parts 257 and 258), underground injection control (UIC) (40 CFR parts 144, 146, and 148), and uranium mill tailings disposal (40 CFR part 192). We have also incorporated MCLs to protect ground-water resources in our generic spent nuclear fuel, high-level waste and transuranic radioactive waste disposal regulations (40 CFR part 191). These regulations apply to the land disposal of these materials everywhere in the United States except Yucca Mountain. As several commenters pointed out, all analyses projecting the performance of the Yucca Mountain repository indicate that ground water is by far the most important pathway for transport of radionuclides (comments 26 and 405, for example). Therefore, we agree with the comments that the ground-water standards should provide protection at least equivalent to those presently in effect for public water systems under the purview of the Safe Drinking Water Act (comments 25, 59, 120, 129, 178, 194, 295, 306, 342, 356, 390, 428, 444, 529). However, comment 444 further states that limiting the compliance period to 10,000 years ultimately violates the SDWA, since concentrations beyond 10,000 years may exceed the MCLs. We disagree. Although our standards to protect the ground-water resource use the same levels as the MCLs developed under the SDWA, the Yucca Mountain disposal system itself is not subject to radiation standards under the SDWA. A further discussion of the 10,000-year regulatory timeframe is in Section 3 of this document.

In the case of pollution prevention activities, reaching the MCL is considered a failure of prevention. Assuring that ground-water contamination will not exceed the MCLs prior to facility operation means that the burden of environmental protection is borne by those benefitting from the facility in question, rather than having future generations expend resources to clean up contamination from the facility. Assuring that the proposed Yucca Mountain repository is protective of ground-water resources is also consistent with a basic principle of radioactive waste disposal; namely, that no undue burdens from radioactive waste disposal should be imposed upon future generations. (See "The Principles of Radioactive Waste Management," Safety Series No. 111-F, International Atomic Energy Agency, Vienna, Austria, 1995, Docket A-95-12, Item V-A-10.) We believe that it is appropriate to apply this fundamental and widely accepted concept to the Yucca Mountain repository (comments 50, 67, 73, 205, 390, 481).

Comments 295 and 445 assert that the ground-water standard should apply to man-made radionuclides from all sources in the vicinity of Yucca Mountain, such as numerous past and present activities at NTS, and contributions from the closed Beatty low-level radioactive waste disposal site. EPA does not agree that the Yucca Mountain ground-water protection standard should necessarily apply to those source terms; however, we refer to DOE's DEIS. Section 8.3.2 of the DEIS evaluates the potential impact of radionuclides at NTS on ground water downgradient of Yucca Mountain, and finds that it would not approach the MCLs within 10,000 years, even under conservative assumptions. Over longer time periods, the effect of contamination from NTS is a small fraction of the peak doses projected from the Yucca Mountain repository. Since other activities at NTS and at the Beatty site represent a much smaller radionuclide inventory, exposures from those sources would be a fraction of that from weapons-related radionuclides. We believe that a more rigorous analysis likely would result in even lower estimates.

With respect to whether EPA is providing "equivalent" protection to ground water at Yucca Mountain as has been provided at the WIPP TRU radioactive waste repository in New Mexico, we believe that the site-specific considerations that have informed our regulatory decisions are appropriate and do result in equivalent protection. The 1987 amendments to the NWPA specify that the Yucca Mountain site is the only potential repository site at which DOE may conduct site characterization activities. Therefore, since passage of the 1987 amendments, the Yucca Mountain site has been under an intense site characterization effort by DOE. Because of these efforts, we have a significant amount of information regarding past, present, and planned population patterns; land use; engineered design; and the hydrogeological characteristics of the host rock. It is apparent that ground water will flow predominantly in a southerly path from the Yucca Mountain repository. See the Yucca Mountain Draft Environmental Impact Statement, Chapter 3 (DOE/EIS-0250 D, July 1999, Docket A-95-12, Item V-A-4), and the Viability Assessment (Docket A-95-12, Item V-A-5). In addition to this extensive data base, we have the scientific recommendations of the Yucca Mountain NAS panel. Significantly, the NAS panel endorsed the use of present knowledge using "cautious but reasonable" assumptions in defining the exposure scenario (NAS Report, p. 100).

None of the information we have reviewed suggests that it is likely or reasonable that year-round residents will locate within 5 kilometers of the proposed repository footprint. As discussed in Chapter 8 of the BID, it would be extremely difficult to farm that close to Yucca Mountain, partly because extracting ground water at that location would be both technically challenging and prohibitively expensive for an individual or small group. In addition, much of this area has rough terrain and soils not conducive to farming. Our understanding of projections of future land development indicate limited population growth farther north of Lathrop Wells (see Appendix I of the BID), with the southernmost border of NTS serving as the limit of this projected development. Given the small likelihood of a year-round resident at 5 kilometers, we chose not to select a distance of 5 kilometers as a compliance point for the site-specific standards at Yucca Mountain. For additional discussion on other possible points of compliance for ground-water protection (see the "Summary of Final Decision" above, and Issues H and I below).

In evaluating the situation at the WIPP, we find that year-round residents already exist approximately 5 kilometers from the repository (see Chapter 2, Volume I, Title 40 CFR part 191 Compliance Certification Application for the Waste Isolation Pilot Plant, DOE/CAO-1996-2184, October 1996, Docket A-93-02, Item II-G-1). Also, the terrain surrounding the WIPP is much more accessible than that at Yucca Mountain. Some have argued that the quality, current use, and potential future use of the ground water at Yucca Mountain calls for more stringent regulation than the ground water at the WIPP, which is largely saline and not potable (comments 178, 342). However, taking the available information into account, we conclude that applying the MCLs at the boundary of the controlled area is consistent with our national policy to protect ground-water resources and our generic standards in 40 CFR part 191. The intent of using the MCLs as a compliance measure for the Yucca Mountain disposal system is to encourage a robust repository that will not result in unacceptable contamination during the regulatory time frame. We believe that the use of contaminated ground water for purposes that could result in exposures to individuals should be of concern, and that avoiding contaminating useable ground-water resources is in the general interest of the public at large.

Comment 133 suggests specific ground-water monitoring actions that should be taken to provide early warning of releases and to assess repository performance. EPA included post-closure monitoring of the disposal system as an assurance requirement in 40 CFR 191.14. We requested comment as to whether we should specify such assurance requirements applicable to the Yucca Mountain disposal system, and declined to include them in our final rule. We have left this to NRC as a matter of implementation, and expect NRC to include such a requirement in its final 10 CFR part 63. DOE has been conducting ground-water monitoring for a number of years as part of its site characterization activities, and DOE and NRC will determine a monitoring program that is feasible and appropriate to implement during repository operations and after final site closure. Nye County has installed monitoring wells farther downgradient of the Yucca Mountain site.

Issue B: Separate ground-water protection standards are unnecessary or inappropriate at Yucca Mountain.

1. A separate ground-water protection standard for Yucca Mountain is redundant and unnecessary since an all pathways individual dose standard that includes the ground water pathway is fully protective of public health. (21, 203, 214, 233, 238, 270, 402, 420, 448, 550, 574, 595, 620, 631)

2. EPA was directed to develop an alternative MCL that would represent a risk comparable to that incurred from naturally-occurring radon in outdoor air. By our calculations, such an alternative MCL for a single radionuclide would correspond to an annual risk of 3.8×10^{-5} or more than twice that arising from exposure to an all-pathway, all-nuclide limit of 0.25 mSv (25 mrem) for Yucca Mountain. (621)

3. The proposed ground-water protection standard represents a misapplication of the Maximum Contaminant Levels (MCLs) of the Safe Drinking Water Act, which apply to drinking water provided by public water supplies. EPA should not require the expenditure of potentially significant amounts of taxpayer money to prevent potential contamination of ground water that may require treatment prior to use anyway. (277, 597)

4. [EPA's Groundwater Strategy] does not dictate generic imposition of tap water standards for all groundwater or a demonstration of compliance with such standards for 10,000 years. In fact, that strategy is flexible and allows for consideration of site-specific factors. . . There has been no analysis of the costs and feasibility to justify the strategy of applying tap water standards to groundwater. (635)

5. A separate ground water protection standard provides less, or no, additional public health and safety benefit. (2, 212, 634)

6. Since the most likely pathway of radiation exposure is ground water, the proposed ground-water protection standard effectively preempts the proposed 15 millirems/year individual-

protection standard and becomes the de facto standard instead of the individual protection limit called for by the Energy Policy Act of 1992. (276, 596)

7. The proposed ground-water protection standard lacks consistency with the individual-protection standard in terms of compliance location and dose methodology. The individual-protection standard is derived from EPA's latest dosimetry models, whereas the proposed ground-water protection standard is based on a 25-year-old regulation (i,e, the Safe Drinking Water Act), which in turn is based on 40-year-old dosimetry. (396, 397, 642)

8. A separate ground water protection standard is contrary to the statutory requirements. EPA is not required to promulgate a separate groundwater standard for Yucca Mountain. (420, 630)

9. A separate ground-water protection standard is inconsistent with the findings and recommendations of the National Academy of Sciences. The NAS did not recommend, and in fact specifically rejected, a separate groundwater protection standard. Therefore, adoption of a separate groundwater protection standard would be contrary to and inconsistent with the NAS findings and recommendations, and would constitute arbitrary and capricious agency action. (182, 189, 420, 530, 632)

10. A separate ground water protection standard may hinder/complicate the development/licensing of the proposed Yucca Mountain repository. (2, 586, 634)

11. A separate ground-water protection standard would force a non-optimal repository design. (235, 448)

12. It is inappropriate for a separate ground-water protection standard to regulate natural sources of radiation. EPA's proposal to combine estimated releases from the Yucca Mountain disposal system with the pre-existing naturally occurring or man-made radionuclides for radium-226, radium-228, and gross alpha activity to determine the concentration in the representative volume is acceptable. However, repository performance is not related to background radionuclides. (249, 637)

Response to Issue B:

EPA does not believe that the ground-water protection standards are redundant and unnecessary (comments 21, 203, 214, 233, 238, 402, 420, 448, 550, 574, 595, 620, 631), nor do these standards result in less public health and safety benefits (comments 2, 212, 634). Rather, EPA believes that the ground-water protection standards are complementary to the public health and safety standards that apply to the proposed Yucca Mountain repository, and serve a vital function. We have included a separate ground-water standard as a matter of policy. Because it is directed specifically at human health, the individual-protection standard of 15 millirems/year, by itself, would address ground-water resources and the viability of ecological habitats less effectively than would separate ground-water protection standards. We believe that ground-water protection standards will confer greater protection to aquatic or biological communities by limiting the contamination of ground water that would discharge to the surface, such as springs or seep areas. Moreover, as discussed in the responses to the set of comments grouped under Issue A, we have a long-standing policy to encourage protection of ground-water resources in a consistent manner in our programs that may affect ground water quality directly or indirectly.

Comment 621 states that EPA was directed to develop an alternative MCL that would represent a risk comparable to that incurred from naturally-occurring radon in outdoor air, and asserts that such an alternative MCL for a single radionuclide would correspond to an annual risk of 3.8×10^{-5} or more than twice that arising from exposure to an all-pathway, all-nuclide limit of 0.25 mSv (25 mrem) for Yucca Mountain. EPA does not believe that the issue raised in this comment is relevant to the Yucca Mountain standard. The comment is a response to Question 15 in the preamble, which noted that some countries have established individual-protection limits higher than the level of 150 mSv/year (15 mrem/year) proposed by EPA for Yucca Mountain and, in fact, that other Federal authorities have also suggested higher individual-protection limits (e.g., 25 mSv/yr, or 25 mrem/year) with no separate ground-water protection provisions. (See 64 *FR* 47011, August 27, 1999.) In response to Question 15, the commenter pointed out that the approach for determining the radon MCL, based on Congressional direction, would result in a radon MCL well above the proposed limit of 15 mrem/year, or the 25 mrem/year limit recommended by this comment. This appears to support the commenter's contention that an all-pathways limit of 25 mrem/year, with no separate ground-water protection standards, would be sufficiently protective for Yucca Mountain. EPA is well aware of the complex issues associated with establishing an appropriate MCL for radon. Radon in drinking water is a naturally occurring contaminant, while EPA's standards for Yucca Mountain are primarily focused on limiting the releases of man-made radionuclides. While radon is ubiquitous in the environment and presents some cost and technical challenges to control at public water supplies, the radionuclides associated with the Yucca Mountain disposal system have been purposely created by man for energy and defense-related purposes. At each step, these man-made radionuclides have been managed and contained according to applicable regulations and the final challenge is to contain these radionuclides in a disposal system for extended periods of time. Naturally occurring radon in drinking water and the containment of man-made radionuclides in the Yucca Mountain disposal system are therefore two very different undertakings. Further, radon is not listed by DOE as a radionuclide in the expected inventory of radionuclides to be disposed at Yucca Mountain (see Table A-10 of the Yucca Mountain Draft Environmental Impact Statement, Docket A-95-12, Item V-A-4). In any case, the separate and distinct issues associated with establishing an MCL for radon have little if any bearing on establishing appropriate ground-water protection or individual protection standards at Yucca Mountain.

EPA does not believe that utilization of the SDWA MCLs in the ground-water protection standard constitutes a misapplication of those standards (comments 277, 597). As discussed above, EPA's Ground-Water Protection Strategy was developed as a comprehensive ground-water protection strategy that serves to guide Agency action where contamination of ground water is of concern. The Ground-Water Protection Strategy presents a clear statement of policy that emphasizes pollution prevention. It was developed based on significant input from state and local governments, other Federal agencies, environmentalists, industry, and public interest groups, among others. The Ground-Water Protection Strategy has guided the course of EPA and state efforts with a clear priority on preventing ground-water contamination. If the Yucca Mountain repository is constructed and high-level radioactive waste disposed therein, it will result in disposal of a large inventory of long-lived radioactive materials directly over aquifers that presently supply ground-water resources to populations in the vicinity of Yucca Mountain. Part D (Agency Policy on EPA's Use of Quality Standards in Ground-Water Prevention and Remediation Activities) of the Ground-Water Protection Strategy states that, in the case of pollution prevention, allowing ground water that is a source of drinking water to be contaminated to a level that equals or exceeds the appropriate MCLs constitutes a failure of pollution prevention. Should this situation occur, future generations will have to decide whether to forego use of the ground-water resource or to expend substantial resources to clean up contaminated ground water. This would violate one of the primary principles in radioactive waste management, accepted nationally and internationally, that radioactive waste disposal should place no undue burdens upon future generations (see, for example, Principle 4: Protection of Future Generations in the IAEA's "The Principles of Radioactive Waste Management, Safety Series No. 111-F", 1995, Docket A-95-12, Item V-A-10). Therefore, use of the MCLs as part of the ground-water protection standard is appropriate.

The comment (597) that implies that EPA's ground-water protection standard will result in separate and additional expenditures to prevent potential ground-water contamination is incorrect. In the DEIS, DOE states that the repository design has evolved to address long-term uncertainty and concerns over licensing requirements that are not related to the EPA standard (page S-20, Summary, Yucca Mountain DEIS, Docket A-95-12, Item V-A-4). DOE's TSPA results indicate that the current design of the repository will meet both the individual-protection and ground-water standards by at least an order of magnitude (see Volume 3, Chapter 4 of the Viability Assessment, DOE/RW-0508, Docket A-95-12, Item V-A-5; Chapter 8 of the Yucca Mountain DEIS, Docket A-95-12, Item V-A-4, and Chapter 4 of the Yucca Mountain Science and Engineering Report, Docket A-95-12, Item V-A-27). Further, as stated in the Viability Assessment (Volume 1, Section 1), "uncertainties remain about the key natural processes, the preliminary design, and how the site and design would interact . . . DOE will continue to improve the repository design to provide extra margins of safety and will conduct additional research and testing to reduce remaining uncertainties." The expected performance for the current repository design, EDA II, projects no radiation doses for more than 100,000 years. Therefore, we conclude that our standard has virtually no impact on the ultimate cost of the repository [see Section 1 of this document, as well as our Economic Impact Assessment for a more complete discussion on this point (Docket A-95-12, Item V-B-2)].

Comment 635 states that the Ground-Water Protection Strategy does not dictate generic imposition of tap water standards for all ground water or a demonstration of compliance with such standards for 10,000 years; and states that there has been no analysis of the costs and feasibility to justify the strategy of applying tap water standards to ground water. The Ground-Water Protection Strategy allows EPA to exercise judgment in applying ground-water standards, in particular in consideration of site-specific factors. From a site-specific perspective, remediation of ground water contaminated as a result of releases from the proposed Yucca Mountain repository would be prohibitively expensive and technically daunting. Present information on the aquifers beneath the proposed Yucca Mountain repository indicates that existing water quality meets the radiological MCLs and, therefore, do not have to be treated for radionuclides to provide drinking water. Many current residents rely on wells that directly supply drinking water (See Chapter 8 of the BID), and it would be reasonable to assume that such behavior would continue into the foreseeable future even if the population increases significantly. In the future, it is possible that contamination from previous underground testing and the Greater Confinement Disposal facility could contribute extremely small doses but not enough to cause the MCLs to be exceeded (see Sections 3.1.4.2.2 and 8.3.2 of the Yucca Mountain Draft Environmental Impact Statement, DOE/EIS-0250D, July 1999, Docket A-95-12, Item V-A-4). As a result, we see no conflict in using the MCLs to preserve the existing quality of ground water. We believe this to be a far more effective strategy than relying on the possibility of after-the-fact treatment. As stated above, we believe our standards will have no effect on the ultimate cost of the repository (see the EIA, Docket A-95-12, Item V-B-2).

Comments 276 and 596 assert that the proposed ground-water protection standard effectively preempts the proposed 15 millirems/year individual-protection standard and becomes the de facto standard instead of the individual protection limit called for by the Energy Policy Act of 1992. The intended purpose of the ground-water protection standards is not to preempt the individual protection standard. The ground-water protection standards are intended to protect a vital natural resource and, therefore, to serve a useful and complementary purpose to the all-pathways health and safety standard. While it is true that ground water would be the most likely source of exposure, it is possible that an individual or small group of nearby residents may receive significant radiation doses from a variety of pathways other than drinking water. Given that there are a variety of agricultural practices in the vicinity of Yucca Mountain (Chapter 8, BID, Docket A-95-12, Item II-A-10), an individual or small group would likely receive primary protection from the all pathways individual-protection standard. In such a case, drinking water would be only one of many pathways of exposure. Pathways other than ground-water may result in significant radiation doses due to bioaccumulation in certain environmental pathways (irrigation of crops, meat ingestion, fish farming). EPA believes that both the ground-water protection standards (incorporating the MCLs to protect ground-water resources), and the individual protection standards (as embodied in an all-pathways standard), are complementary and provide both public health protection and protection of the vital natural resource.

Comments 396, 397, and 642 assert that the proposed ground-water protection standards are inconsistent with the individual-protection standard in terms of (1) compliance location; (2) dose methodology, and (3) dosimetry. Regarding compliance location, we have selected the same location in our final rule for assessing compliance with the individual-protection standard and the ground-water protection standards.

The differences in dose methodology and dosimetry arise in acknowledgement of an existing approach for protecting ground water as opposed to the requirement to develop a new limit defining protection of individuals in the case of Yucca Mountain. Individual-protection standards have evolved over the decades and have been applied to a wide variety of radiation protection practices. Today, EPA is using the annual committed effective dose equivalent methodology for its new individual-protection standard, consistent with contemporary radiation protection practice.

In the case of ground-water protection standards, however, EPA has a long-standing policy to encourage protection of ground-water resources in a consistent manner. As pointed out earlier in these responses to comments, EPA has articulated its ground-water protection principles in the 1991 Strategy (Docket A-95-12, Item II-A-3) and further, has used the MCLs as a primary benchmark for environmental protection in a variety of regulatory programs.

EPA promulgated the 4 millirems/year MCL for man-made beta and photon emitting radionuclides in 1976 (41 *FR* 28402, July 9, 1976). This is a total dose equivalent to any organ or the whole body and incorporated the best scientific knowledge regarding the relationship between radiation exposure and risk that existed in 1975. Yet, the MCLs for radionuclides have a long institutional history and apply to thousands of public water supplies, serving to define when drinking water is safe to drink. The essence of the MCLs are radionuclide concentrations. Note that 40 CFR 141.16 lays out a clear methodology for determining the concentrations. In addition, EPA's publication "National Interim Primary Drinking Water Regulations," (EPA-570/9-76-003, Docket A-95-12, Item V-A-8) provides a listing in Appendix B of the concentrations of man-made radionuclides yielding an annual dose of 4 millirems/year (see Table IV-2A). At the same time, dose modeling to determine compliance with the all-pathways individual-protection standard will determine media-specific concentrations (e.g., air, surface water, ground water) as an intermediate step leading to the calculation of committed effective dose equivalents, taking into account each individual pathway of exposure (e.g., inhalation, ingestion of food or drinking water). While the dose methodologies for the ground-water protection standards and the individual-protection standards are different, they both begin with the same basic media-specific and pathway-specific concentrations. Given the well-established concentrations of the MCLs and the capabilities of today's sophisticated performance assessment modeling systems, we believe compliance with the ground-water protection provisions and the individual-protection requirements are feasible with minimal adjustments to the models in the case of Yucca Mountain.

While EPA does not believe the different dose methodologies will present any significant issues related to the ability to carry out performance assessments in support of compliance determinations, many commenters have questioned the risk levels represented by the MCLs, given that they were established in 1976 (see Issue C). However, a recent re-evaluation of the risk levels associated with each of the 1976 MCLs (the existing MCLs) using the methodologies described in Federal Guidance 13 finds that, in general, the existing MCLs for beta-photon emitters fall within the Agency's lifetime risk range goal of 10^{-4} to 10^{-6} (see 65 *FR* 76708-76717, December 7, 2000).

The comments grouped at 13 assert that the ground-water protection standards are contrary to the statutory requirements (420, 630). EPA does not believe that the ground-water protection standards are in any way contrary to the statutory requirements of the EnPA. Section 801(a) of the EnPA directs EPA to promulgate "public health and safety standards for the protection of the public from releases from radioactive materials stored or disposed of in the Yucca Mountain site." The Act specifically requires that EPA promulgate an individual dose limit as one element of the standards. The fact that Section 801(a)(2) states that EPA's standards, including an individual dose standard, "shall be the only such standards applicable to the Yucca Mountain Site," does not forbid EPA from establishing a separate ground-water protection standard for protection of the vital ground-water natural resource. In specifying that EPA's public health and safety standards for protection of the public from releases from radioactive materials stored or disposed at Yucca Mountain "shall be the only such standards applicable to the Yucca Mountain site," (emphasis supplied), Section 801(a)(2) is not intended to preclude promulgation of any other environmentally protective standard. Rather, the legislative intent in specifying that these be the "only such standards" applicable to Yucca Mountain was two-fold. First, the intent was that no other governmental body be able to set public health and safety standards that supercede the EPA standard or that place additional restrictions on the Yucca Mountain repository. For example, even EPA's generally applicable environmental standards for spent nuclear fuel, high-level and transuranic waste at 40 CFR 191 are expressly prohibited from being applicable at Yucca Mountain, and NRC is required to adapt its proposed licensing process to conform with EPA's final Yucca Mountain standard (EnPA, Section 801(b)(1)). Second, EPA's public health and safety standard is required to prescribe the maximum annual effective dose equivalent to individual members of the public from releases to the accessible environment from radioactive materials stored or disposed of in the repository. We do not believe that there is any basis to interpret the language of the EnPA as prohibiting EPA from exercising its statutory authority to protect the environment, in this case, the vital ground-water natural resource, from degradation.

The comments grouped at 9 assert that the ground-water protection standards are inconsistent with the findings and recommendations of the National Academy of Sciences (182, 189, 420, 530, 632). Comment 530 further states that adoption of a separate ground-water protection standard - which it purports to be contrary to and inconsistent with the NAS findings and recommendations - would constitute arbitrary and capricious agency action. First, EPA disagrees that the ground-water protection standards are inconsistent with the findings and recommendations of NAS (182, 189, 420, 530, 632). In its report, NAS clearly identified the ground-water pathway as one of the significant pathways of exposure in the vicinity of the Yucca Mountain site (NAS Report, pp. 52 and 81). The NAS also acknowledged that separate ground-water standards have as a goal the protection of ground water as a resource (NAS Report, p. 121). The NAS did not, however, make a specific recommendation that EPA either include or not include a separate ground-water protection provision in our environmental protection standards for Yucca Mountain, but, rather, based its recommendations "on those requirements necessary to limit risks to individuals" (NAS Report, p. 121). In its comments on the proposed rule, NAS specifically addressed our proposal to include a separate ground-water protection standard for the Yucca Mountain site:

> "[i]n the preamble [to the proposed rule], EPA implies that there is a scientific basis for inclusion of separate ground-water limits in the standards – for example, EPA provides a detailed analysis of approaches to calculating such limits . . . .The [NAS] respectfully disagrees and does not believe that there is a basis in science for establishing such limits for the reasons described above. The [NAS] recognizes EPA has the authority under the Energy Policy Act to establish separate ground-water limits as a matter of policy, but if it does so it should explicitly state the policy decisions embedded in the proposed standard and ask the public to comment on those decisions.

> "If EPA wishes to establish such standards on the basis of science, it must make more cogent scientific arguments to justify the need for this standard" (NAS Comments, p. 11, Docket A-95-12, Item IV-D-31).

Thus, NAS specifically concluded that EPA has full regulatory authority to promulgate ground-water protection standards, as long as EPA does not misstate its rationale as based on scientific determinations regarding protection of public health and safety.

EPA also strongly disagrees that the adoption of a separate ground-water protection standard is arbitrary and capricious Agency action (530). Moreover, this comment stated that NAS specifically rejected a separate ground-water protection standard. This is either a misinterpretation or a misrepresentation of the NAS findings and recommendations. As discussed above, NAS neither recommended inclusion of a ground-water protection standard, nor explicitly recommended that EPA not include such a standard. The comment seems to imply that EPA cannot promulgate any standard or any aspect of any standard that was not specifically recommended by NAS, and, if it does so, such action is *per se* arbitrary and capricious. EPA disagrees with such a reading of the EnPA on the basis that it is directly contrary to the unambiguous meaning of the statute. In the Conference Report that accompanied the Energy Policy Act, the Conference Committee stated explicitly that the role of the NAS panel was to provide "expert scientific guidance," but that Section 801 is not intended to limit EPA's discretion in the exercise of its regulatory authority:

> The Conferees do not intend for the National Academy of Sciences, in making its recommendations, to establish specific standards for protection of the public but rather to provide expert scientific guidance on the issues involved in establishing those standards. Under the provisions of Section 801, the authority and responsibility to establish the standards, pursuant to rulemaking, would remain with the Administrator, as is the case under existing law. The provisions of Section 801 are not intended to limit the Administrator's discretion in the exercise of his authority related to public health and safety issues [H.R. Rep. No. 1018, 102nd Cong., 2d Sess. 391 (1992)].

Moreover, EPA's interpretation of the EnPA as not limiting the Agency's regulatory authority in this rulemaking is consistent with the views EPA expressed to Congress during deliberations over the legislation. The Chairman of the Senate Subcommittee on Nuclear Regulation requested EPA's views of the bill reported out of conference. The Deputy Administrator of EPA indicated that the NAS Report would provide helpful input. The Deputy Administrator pointed to the language, cited above, stating the intent of the Conferees not to limit our rulemaking discretion, and assured Congress that any standards for radioactive materials that we ultimately issue would be the subject of public comment and involvement [138 Cong. Rec. 33,955 (1992)].

EPA's interpretation also is consistent with the role that both NAS and Congress understood NAS would fulfill. During the Congressional deliberations over the legislation, NAS informed Congress that while it would conduct the study, it would not assume a standard-setting role because that is properly the responsibility of government officials [138 Cong. Rec. 33,953 (1992)].

Therefore, EPA does not believe that its proposal deviated in any respect from the legislative mandate of the EnPA. Thus, the legislative history of Section 801 of the EnPA speaks to this issue quite clearly and expressly belies any interpretation to the effect that valid exercise of the Agency's lawful and authorized regulatory authority in this context is somehow arbitrary and capricious.

Comments also asserted that a separate ground-water protection standard may hinder/complicate the development/licensing of the proposed Yucca Mountain repository (2, 586, 634), or that a separate ground-water protection standard would force a non-optimal repository design (235, 448). The primary purpose of the ground-water protection standards is to safeguard and protect the vital ground-water natural resource. It would be inappropriate for EPA to establish an environmental protection standard on the basis of licensing considerations. Moreover, the DEIS and Viability Assessment indicate that the current repository design would be able to meet the proposed standard.

EPA similarly disagrees that the ground-water protection standards will be detrimental to the performance of the repository. One commenter claims that the repository design must be adjusted to meet the ground-water standard, and refers to DOE's DEIS as showing that the best design from a ground-water perspective is the worst performer from an individual protection perspective. The commenter cites DOE's finding that meeting the ground-water standard requires additional excavation, ventilation, and material handling, increasing exposures from radon emissions and to workers over the operational period of the repository. The commenter also concludes that the ground-water standard adds additional expense to the design and construction of the repository without a corresponding increase in protectiveness. Finally, this commenter asserts that EPA has disregarded the NAS recommendation against sub-system performance requirements. We disagree that these comments accurately reflect the Yucca Mountain situation regarding the impacts of our standard on repository design. First, an evolving design is a natural phase of any large engineering or construction project, and we doubt that the commenter would expect DOE to consider only a single design while site characterization continues. Likewise, performance trade-offs, as well as trade-offs of performance, time, and cost, are to be expected in evaluating multiple project designs. Second, the commenter acknowledges that all of the various designs described in the DEIS "met both proposed NRC and proposed EPA standards for overall health protection."
Further, the DEIS shows that the increase in expected doses to the public attributable to Rn-222 during this period are insignificant (see Section 8.2.2 of the Draft DEIS for Yucca Mountain, Docket A-95-12, Item V-A-4). Also, the EPA standard in subpart A of the proposed rule (standards applicable to storage) does not apply to site workers. Workers are subject to NRC and DOE requirements, which allow higher exposures related to occupational activities than for the general public. As for sub-system requirements, we note NAS's comment that "[t]he proposed EPA standards do not contain subsystem requirements and, therefore, are consistent with the recommendations in the TYMS report" (Docket A-95-12, Item IV-D-31).

Comments 249 and 637 assert that it is inappropriate for a separate ground-water protection standard to regulate natural sources of radiation and that repository performance is not related to background radionuclides. EPA's Yucca Mountain standard only applies to radionuclides released from the Yucca Mountain disposal system. At the same time, EPA uses the MCLs as the benchmark to limit the contamination of the representative volume of ground water. The MCLs incorporate provisions that relate to man-made and other [Ra-226 + Ra-228, gross alpha (excluding uranium and radon)] radionuclides. To the extent that these radionuclides are already present in the representative volume of ground water, the allowable releases from Yucca Mountain may be limited so that the radionuclides in the representative volume of ground water do not exceed the MCLs. This is to preserve the water quality of the resource at risk.

Information on the existing levels of radionuclides in ground water in the vicinity of the Yucca Mountain site indicates radionuclide concentrations "well below" the MCLs (see Table 3-19, Section 3.1.4.2.2 of the Draft Yucca Mountain EIS, Docket A-95-12, Item V-A-4). Further, projected impacts from past, projected and reasonably foreseeable future disposals are estimated at no more than a few percent of that to be expected from the Yucca Mountain repository. This includes a wide variety of activities, the most important of which are the residue from underground testing of nuclear weapons, the disposal of radionuclides at the Greater Confinement Disposal facility, and the shallow land disposal of low-level radioactive waste at the nearby Nevada Test Site (see Section 8.3.2 of the Draft Yucca Mountain EIS, Docket A-95-12, Item V-A-4). Based on the existing and projected radionuclide concentrations in ground water in the vicinity of the Yucca Mountain repository, the MCLs will serve as the effective limits to contamination of the representative volume of ground water.

Issue C: The MCL approach to ground water protection is misapplied to the Yucca Mountain site and is based on outdated dosimetry methodology that results in widely varying risk.

1. 1975 MCL's are NOT acceptable today. The dosimetry methods in the 1976 methodology are outdated particularly relative to equating them to risk. (74, 172, 546)

2. Current understanding of the risk posed to individual organs by radiation exposure demonstrates that the MCLs for individual radionuclides provide a level of protection that varies significantly. (594)

3. Application of a groundwater standard is without scientific basis in this case, in part because of the wide isotopic variability of the EPA MCL (and the resultant implied individual dose variability). We conclude that the groundwater calculation specified by EPA lacks scientific meaning due to outdated maximum concentration limits of isotopes and is an unnecessary compliance complication. (324)

4. If a separate groundwater standard is to be promulgated, we consider that it is appropriate for the EPA to abandon the more than 25-year old MCL methodology in favor of a standard of no less than 10 mrem/year CEDE. (771)

5. As aptly noted in EPA's preamble to the proposed Part 197 standards, application of the MCLs would render differing and inconsistent exposure levels that differ from the IPS.

Under these circumstances, the proposed GPS cannot be determined to be rationally related to ensuring adequate protection of public health and safety in the context of the Yucca Mountain site. (633)

6. Certain MCLs maintain a risk level so small that the individual, all-pathway dose limit is meaningless. . . Consequently, the groundwater protection criteria become the de facto standards instead of the individual protection limit called for by the Energy Policy Act of 1992. (596)

7. The MCLs were based on an analysis of treating contaminated water in public drinking water systems subject to the SDWA and not on an analysis of technology and costs of remediating groundwater at actual sites. In this rule, EPA proposes to apply the same MCLs to groundwater supplies before treatment rather than "at the tap" after treatment. Therefore, in the absence of an appropriate and comprehensive cost-benefit analysis, EPA should not require the expenditure of potentially significant amounts of taxpayer money to prevent potential contamination of groundwater that may require treatment prior to use anyway. (597)

8. Among other things, the MCLs under the SDWA apply "at the tap," after treatment, rather than to groundwater sources. Furthermore, the MCLs are required to reflect treatment feasibility and cost; such issues are not germane to, and have not been considered for, the proposed GPS. The MCLs are generally implemented through sampling and quarterly averaging; these concepts likewise are not applicable to and not incorporated into the proposed GPS. Many of the radionuclides at issue for the potential repository are not specifically addressed by the MCLs. (633)

9. EPA has not articulated a reasonable explanation for its use of ICRP-2 in this rulemaking while it has proposed the revised methodology of ICRP-30 in other related contexts such as the proposal on revised MCLs. Failure to consider this important aspect of the groundwater standard would render any final rule "arbitrary and capricious" under current case law. (642)

Response to Issue C:

Numerous comments asserted that the MCLs, which were originally promulgated in 1976, are based on an outdated methodology that results in varying risks for different radionuclides, thus providing levels of protection that vary significantly (comments 74, 172, 324, 546, 594, 633, 642, 771). Comment 324 went so far as to state that the ground-water standard "lacks scientific meaning due to outdated maximum concentration limits of isotopes and is an unnecessary compliance complication." It is true that the pertinent MCL does not represent a uniform risk for all radionuclides because the beta/photon MCL is based on a dose limit, not a uniform risk limit. Specifically, the MCL limits the *critical organ dose* from ingested beta/photon emitters to 4 mrem/y. For many radionuclides this type of dose limit leads to non-uniform, partial body irradiation and variable cancer risks; however, this does not render the standard scientifically meaningless. Different ingested radionuclides emit radiation of various energies, produce differing doses to nearby tissues, are transported to various locations in the body or are excreted, and decay to other elements. These processes result in various risks of cancer in the body depending on the radionuclide and the tissue affected.

For example, ^{129}I concentrates predominately in one organ, the thyroid gland, whereas tritium (^{3}H) distributes fairly uniformly throughout the body. In the case of ^{129}I, the thyroid gland is the designated critical organ, and the derived activity concentration corresponding to the 4 mrem/y limit is 1 pCi/L (see Table IV-2A in "National Interim Primary Drinking Water Regulations", EPA-570/9-76-003, A-95-12, V-A-8). For ^{3}H, the total body is the critical organ, and the derived activity concentration at the MCL is 20,000 pCi/L. The table below presents EPA's current estimates of the individual lifetime excess fatal and total cancer risks associated with ingestion of these ^{129}I and ^{3}H activity concentrations, assuming a drinking water intake rate of 2 liter/day, 365 d/y, for 70 y, and using radionuclide-specific mortality and morbidity coefficients from Federal Guidance Report No. 13 (EPA 402-R-99-001, September 1999, Docket A-95-12, Item V-A-20).

Table of EPA estimates of the annual and lifetime fatal cancer risks associated with ingestion of ^{129}I and ^{3}H at activity concentrations corresponding to the 4 mrem/y beta/photon MCL.

Isotope	MCL (pCi/L)	Lifetime Excess Fatal Cancer Risk	Lifetime Excess Total Cancer Risk
I-129	1	8×10^{-7}	8×10^{-6}
H-3	20,000	4×10^{-5}	5×10^{-5}

As indicated by both the DOE/VA (Figure 4-12) (Docket A-95-12, Item V-A-5) and the DEIS for Yucca Mountain (Tables 8-42, 8-46, and 8-50, Docket A-95-12, Item V-A-4), the primary radionuclides of concern during a 10,000 year regulatory period are carbon-14 (^{14}C), technetium-99 (^{99}Tc), and ^{129}I. These are all beta emitting radionuclides that fall under the 4 millirem/year MCL limitation. When this level was derived in 1976, the cancer risk associated with whole body irradiation (as is the case for ^{14}C and ^{99}Tc) at 4 millirem/year equated to a lifetime cancer risk of 5.6×10^{-5}, assuming a 70-year lifetime. Comment 642 refers specifically to the methodology used to develop the MCLs in 1976 (ICRP-2), and questions EPA's rationale for relying on that methodology when the Agency proposes to use updated methodologies, such as ICRP-30, in its current actions. However, a recent re-evaluation, using EPA's Federal Guidance Report 13, of the risk associated with each of the 1976 MCL concentration levels corresponding to the 4 millirem/year limit found that "the risks associated with these concentrations, while varying considerably, generally fall within the Agency's current risk target range for drinking water contaminants of 10^{-4} to 10^{-6}" (see 65 *FR* 76716, December 7, 2000). The risk coefficients in Federal Guidance Report 13 were derived using ICRP-30 and later ICRP methodologies. Based on these generally consistent results, and despite the differing methodologies, EPA is not revising the MCL for beta-photon emitters at this time.

Moreover, EPA has applied MCL levels to waste disposal efforts throughout the country for many years, and the MCLs apply to the WIPP, a geologic repository for long-lived TRU radioactive wastes. Under the principle of inter-generational equity, EPA regards MCLs as an appropriate measure to be applied to these types of activities to protect ground-water resources from potential contamination. By attempting to limit potential ground-water contamination to the MCL limits, we are acting consistent with the principle of intergenerational equity, i.e., by restricting pollution potential of the initial waste disposal practice, we are not allowing the burden of cleaning drinking water supplies to be passed on to future generations. We consider this approach to be consistent with Agency and national policy to protect ground-water resources for future use (see the responses to Issues A and B above on the need for separate ground-water standards).

Comment 596 asserts that the ground-water protection criteria become the *de facto* standards, rather than the individual protection limit expressly authorized by the EnPA. While this is certainly possible for individual radionuclides, protecting ground-water resources is an Agency and national policy. The two standards, individual protection and ground-water protection, derive from different rationales and apply to different considerations for the disposal system. The individual protection standard is aimed at health protection for individuals potentially exposed to repository releases from any and all pathways. This is a health based standard, to be set consistently with the Agency's judgement on acceptable risk levels for these total exposures. In contrast, the ground-water protection requirement is aimed at the protection of ground-water resources for future use by people. Considering that the Yucca Mountain repository is located above potable water aquifers that supply the water needs of current residents downgradient from the repository (BID for 40 CFR part 197, Chapter 7, Docket A-95-12, Item V-B-1), and could supply even larger populations, we feel that ground-water protection is a legitimate and important component of the environmental standard we are establishing. Also considering that potential releases of radionuclides after failure of portions of the engineered containment barriers are largely into ground waters below the repository site, protection of the downgradient water resources from contamination appears to be a prudent course and consistent with existing applications under the authority of the Agency (for additional information on the Yucca Mountain repository, see the BID for 40 CFR part 197, Chapter 7, Docket A-95-12, Item V-B-1). Whether the releases for any particular radionuclide are limited by the individual or ground-water protection requirements is a function of the specific conditions at any given repository site as well as the projected release performance of the repository over time. As mentioned above, the two requirements are derived from separate concerns, and so the justification for having both individual and ground-water protection standards is independent of these site-specific details.

Comments 597 and 633 assert that the MCLs apply under the SDWA at the tap and are inappropriately utilized as ground-water standards. These comments also assert that the MCL approach should not be implemented for the Yucca Mountain site without a cost-benefit analysis, since the MCL approach is technology based. EPA believes that it is appropriate to apply the MCLs to groundwater resources at Yucca Mountain for the following reasons:

First, as discussed above, this is a matter of inter-generational equity. The intent of applying the MCLs as part of the ground-water protection standard is to encourage a robust containment and isolation design that will not result in unacceptable contamination during the regulatory time frame, which would require future generations to shoulder the burden of water treatment due to contamination from the wastes. Second, inclusion of the ground-water protection standard is consistent with EPA's certification process for WIPP; which is the only deep geologic disposal facility in the country that has actually gone through a regulatory review and approval process. We do not believe that we should not apply the same approach to protection for the Yucca Mountain disposal facility as we afforded to the population around WIPP. Moreover, the Yucca Mountain disposal system will be located above aquifers that are the ground-water supply for the residents living downgradient from the repository, whereas the aquifers potentially subject to contamination at the WIPP facility are highly saline, non-potable water sources. Third, we employ MCLs to protect ground water in numerous other regulatory programs. Our regulations pertaining to hazardous-waste disposal (40 CFR part 264); municipal-waste disposal (40 CFR parts 257 and 258); underground injection control (UIC) (40 CFR parts 144, 146, and 148); generic SNF, HLW, and TRU radioactive waste disposal (40 CFR part 191); and uranium mill tailings disposal (40 CFR part 192) all incorporate MCLs for purposes of protecting precious ground-water resources. These programs have demonstrated that such protection is scientifically and technically achievable, within the constraints that each program applies ("Progress In Ground-Water Protection and Restoration," EPA 440/6-90-001, Docket A-95-12, Item V-A-6).

EPA does not believe that a cost-benefit analysis is necessary for the application of the MCLs as part of the site-specific Yucca Mountain ground-water protection standard. Application of the MCL limits to other site-specific waste disposal activities is a matter of Agency policy and not predicated on the outcome of site-specific cost-benefit analyses. Analyses of potential ground-water contamination levels for the site performed by DOE show that the current MCL levels are not exceeded at any of the locations for which calculations were performed (distances of 5 to 30 km downgradient from the site). See the Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (DOE/EIS - 0250D, Docket A-95-12, Item V-A-4), and Chapter 4 of the Yucca Mountain Science and Engineering Report (Docket A-95-12, Item V-A-27). More specifically, the Economic Impact Analysis for 40 CFR part 197 presents a series of arguments to demonstrate that the current repository design did not evolve as a direct response to EPA's ground-water protection requirements, and that demonstrating compliance with these requirements does not impose additional costs on the repository program for expensive site characterization studies or repository design efforts. In addition, the Yucca Mountain repository design has evolved in response to the changing understanding of the expected performance of the natural and engineered systems at the site and in an attempt to reduce the impacts of uncertainties in projecting the behavior of the disposal system for compliance assessments. It has not evolved in response to provisions of the EPA standard, or EPA's broader application of MCLs to waste disposal efforts, which have been in place in their current form for some considerable time [see the EIA for 40 CFR part 197 for a more extensive discussion (Docket A-95-12, Item V-B-2)]. EPA's ground-water protection approach in fact requires no additional expensive data collection beyond that necessary to show compliance with the individual protection standard, and therefore imposes no significant additional costs on the DOE effort (EIA for 40 CFR part 197, Chapter 6, Docket A-95-12, Item V-B-2). In addition, details of the compliance analyses (representative volume, use of averaged hydrologic characteristics and methods for calculating contamination plume concentrations) have been specified in §197.31 to reduce potential confusion in implementation and reduce uncertainties in the calculations; further minimizing the difficulty (expense) of demonstrating compliance.

Comment 633 stated that many of the radionuclides at issue for the potential repository site are not specifically addressed by the MCLs. Performance projections for the disposal system presented in the DOE/VA and DEIS documents (Docket A-95-12, Items V-A-4 and V-A-5) show that the radionuclides that contribute to potential doses within the regulatory time frame (10,000 years) are primarily technetium and iodine. These radionuclides do have established MCL levels.

Issue D: What is the appropriate representative volume (RV) for use in assessing compliance with the ground water protection standard? (619)

1. Since the problem is supposed to include the consideration of the critical group who will utilize ground water [inaudible] aquifer that could be impacted by Yucca Mountain, it is also appropriate to incorporate the ground water standard that is consistent with the use of the water for domestic purposes. (70)

2. The 4,000 ac-ft/yr RV is the appropriate value, others are too small for adequate implementation and ignore the current water availability in the region. (215, 470, 636)

3. The preamble to the standard requests comment on alternative dilution volumes that are extremely small (e.g. 10 and 120 acre-feet). These dilution volumes are not reflective of the resource to be protected (the EPA states the representative volumetric flow is 4000 acre-ft/year for the sub-basin in which the proposed repository is located). (598)

4. The RV should be as small as technically achievable. (441)

5. The 1,285 ac-ft RV appears appropriate although a case could be made for higher volumes, smaller volumes are technically not feasible to implement. (561, 307)

6. We consider that the EPA has presented a reasonable assertion and provided sufficient bases for the use of 1285 acre-feet per year as a dilution volume for the CG/RMEI. We do not support the use of any parametric value less than what EPA has proposed here. (772)

7. The requirement in the draft standard of a "representative amount of groundwater" appears to be inconsistent with the SDWA. The smallest public water system whose groundwater is protected under the SDWA may have as few as 15 connections or supply 25 people. The EPA should make its Yucca Mountain standard fully consistent with the SDWA. (294)

8. Modeling considerations based on low water volume available today should not be a principal factor in decision making on the withdrawal point. (293)

Response to Issue D:

A number of comments state that the perennial yield volume of 4,000 acre-feet/yr is the appropriate representative volume because the other volumes are too small for adequate modeling and ignore the current water availability in the region (comments 215, 470, 598, 636).

EPA disagrees that 4,000 acre-feet/yr is the appropriate value for the representative volume. First, there are few wells in the sub-basin and the data necessary to estimate the perennial yield are very poor. The database of hydrologic characterization information for the sub-basin is small and consequently there is a high level of uncertainty for any attempt to derive an accurate number for the perennial yield. Therefore, at best, the 4,000 acre-feet/yr number is a very rough estimate rather than a reliable number (see the BID, Chapter 7 for data on water resources in the Yucca Mountain area). Second, the use of a perennial yield number for calculations assessing the potential of ground-water contamination tacitly allows the entire sub-basin to be contaminated before compliance is an issue. In this connection, the perennial yield is an abstract concept used for the purposes of water budgeting, but does not have a physical reality in that it is not located at any given place in the aquifers potentially vulnerable to contamination by repository releases. Finally, the challenge of the repository effort is to project, with an acceptable level of confidence, the path of potential contamination released from the repository. Analyses to show compliance with ground-water protection requirements must be based on such projections of the path of contaminants (giving recognition to inherent uncertainties to be expected), rather than on a simple assumption that the entire sub-basin can be accepted as a volume of ground water available for contamination. For these reasons, we believe the 4,000 acre-feet/yr perennial yield number is not appropriate as the representative volume.

Comment 441 states that the representative volume should be as small as technically achievable. Comment 294 states that EPA should make the standard fully consistent with the SDWA; the smallest public water system protected under the SDWA may have as few as 15 connections or supply 25 people. EPA concludes that the 10 acre-feet/yr representative volume (which is equivalent to the smallest volume for a public water supply for purely domestic use), is too small a volume for defensible modeling calculations, considering the inherent uncertainties in projecting contaminant migration over the long time frames and distances involved. From a modeling feasibility perspective, we believe a minimum volume of about 100 acre-feet is the lower limit of defensible modeling, considering the uncertainties in time and scale involved in modeling the ground-water flow and contaminant migration downgradient from the repository site (Docket A-95-12, Item II-E-10). Thus, of the four options presented, EPA considers the 120 acre-feet/yr and 1,285 acre-feet/yr options to be practical water volumes for modeling purposes. These volumes were developed from considerations of actual water use information for the current inhabitants living downgradient from the repository site and their current water needs (see discussions in Section 8.2.3.2 of the 40 CFR part 197 BID). For a community large enough to use water for other than entirely domestic purposes, a per capita water use of 0.8 acre-feet/yr is consistent with actual uses. The 120 acre-feet/yr volume would then be consistent with a small rural residential community, which is consistent with short-term population growth projections for the area around 20 km downgradient from the repository. As explained in the preamble to the standard, the 1,285 acre-feet/yr volume corresponds to an alfalfa farm with 225 acres under cultivation (water allotment of 5 acre-feet/yr/acre under cultivation - an average size farm for the Amargosa Valley area with 10 acre-feet/yr for domestic use). Comment 70 states that a water volume consistent with domestic use should be included in the ground-water standard. The 1,285 acre-feet/yr representative volume includes a 10 acre-feet/yr volume for domestic use. As mentioned above, the practical limitations for ground-water and contaminant transport modeling have led us to the conclusion that it is not feasible to confidently project potential contamination over long time periods using a small volume such as 10 acre-feet/yr. The domestic use of ground water is therefore incorporated into the representative volume we have defined. As explained in the preamble to the final rule, we have selected a representative volume of 3,000 acre-feet/yr as a figure more representative of the spectrum of water uses downgradient of the repository that would be protected by the ground-water standards.

Comment 293 states that modeling considerations based on low water volume available today should not be a principal factor in EPA's determination of the appropriate compliance location for the ground-water protection standard. We have not chosen a compliance location on the basis of a water volume consideration. The compliance location was selected as a protective measure to safeguard the water resource for the population directly downgradient from the repository. We selected the southwesternmost border of the NTS as the farthest extent of the controlled area in the predominant direction of ground-water flow because we believe that NTS will continue to be an area permanently withdrawn from public uses because of the activities that have been conducted there that could result in radioactive contamination. Therefore, future human activities are unlikely north of that location. The issue of water accessibility and cost, with deepening of the water table in the direction of the repository, also argues for a lower probability of future human activity in that direction. By placing the compliance location northward of the Amargosa Valley area where current farming activities are located, we are taking a protective approach to safeguarding the resource.

Issue E: Is it reasonable to assume that there will be some degree of mixing with uncontaminated ground water along the radionuclide travel paths from the repository? (293)

1. The degree of potential mixing along flow paths and the modeling approach are implementation details that should be left to NRC. (232, 332, 269, 772)

2. It is inappropriate for the EPA to prescribe any degree of belief in potential modeling approaches that could be part of DOE's license application. (619)

3. Although the proposed standard appears to have a groundwater standard, it is significantly weaker than and out of compliance with EPA's current ground water protection criteria as implemented under CERCLA (Superfund), the WIPP standard and the Safe Drinking Water Act. . . EPA should require strict adherence at all points/locations to the agency's groundwater MCLs without allowing for dilution by volume or distance. (590)

4. EPA should not assume that dilution or mixing with clean water is acceptable. (373)

5. It is reasonable to assume dilution of the pollution at increasingly distal locations. (171)

6. It is reasonable to assume that there will be mixing with uncontaminated groundwater, because preventing such mixing would be essentially impossible. (469)

7. [I]t is reasonable to assume there will be some degree of mixing but, from recent work, it appears the flowpaths beneath the repository will be along fractures, with the water moving generally to the south and southeast until it discharges from the tuff into the alluvial aquifer. This suggests that mixing will be limited for the first 15 to 20 km from the repository area, and probably negligible over the first few kilometers. (389)

8. DOE not only agrees that it is reasonable to assume that the mixing of uncontaminated water occurs along the radionuclide travel paths, but DOE's site characterization studies demonstrate that such mixing occurs. (641)

9. Parameter values should be derived from the collection of reasonably attainable field data and research directed to define more accurately the heterogeneity and variance of these parameter distributions, rather than by substitution of "expert-elicited" values. The analysis must also consider model uncertainty as well as parameter uncertainty, and particularly model linkages. Given the complexity of the saturated-zone flow system downgradient from Yucca Mountain involving both fracture and matrix flow, and contributions from the volcanic, alluvial, and carbonate aquifers, it is reasonable to assume that there will be mixing with uncontaminated ground water along the radionuclide travel paths from the repository. (559)

Response to Issue E:

In the preamble to the proposed rule, EPA specifically requested comment on (i) "[w]hat approach is appropriate for modeling the ground water flow system downgradient from Yucca Mountain . . .," and (ii) "[i]s it reasonable to assume that there will be some degree of mixing with uncontaminated ground water along the radionuclide travel paths from the repository?" (Question 12, 64 *FR* 47010). The purpose of requesting comment on these questions was to gain insight into how the ground-water protection standard could be applied to the Yucca Mountain site in a reasonable manner, given the currently known characteristics of the site. Recognizing that the ground-water flow regime beneath the repository is strongly controlled by water movement through the fractured rocks, the question of how releases from the repository will interact with the surrounding ground-water flow system is important to the approach taken to model the process.

Comments 232, 332, 269, and 772 express concern that the approach to modeling ground-water flow is an implementation issue that should be left to NRC as the licensing authority. EPA has not taken a position on the use of any particular modeling approach for use in assessing ground-water contamination downgradient of the site. We believe that this choice is the responsibility of DOE to propose and defend in the licensing process. We do, however, feel that extreme approaches to modeling the flow-system should be avoided, consistent with our "reasonable expectation" approach to demonstrating compliance with the standard. Extreme approaches to modeling radionuclide transport in fracture dominated flow systems could result in "worst-case" scenarios with assumptions that are unrealistic and excessively conservative as a consequence. Such extreme "worst-case" analyses have the potential to obscure the important processes that actually control the likely performance of the repository system most of the time. By obscuring these processes, it can make it difficult to reach a scientific consensus in the licensing process about whether the processes that control repository performance most of the time are actually understood sufficiently well to make reasonable decisions about the adequacy of the compliance analyses. Consistent with our "reasonable expectation" approach to compliance demonstrations, we believe that the inherent uncertainties involved in understanding the natural processes and events should be recognized and treated realistically in performance projections and an understanding of uncertainties should play a role in compliance decisions.

Some comments point out that mixing of contaminated water from the repository with other water along the flow path is to be expected and can not be avoided (comments 171, 469, 389, 559, and 641), while other comments insisted that no potential mixing should be allowed. EPA believes that the extent of the mixing possible along the flow path from the repository to the compliance point is an important question that DOE's site characterization and modeling must answer. We believe that it would be excessively conservative, to the point of being unrealistic, to assume that repository releases can move from the immediate repository location to the compliance point without interacting, and mixing to some extent, with ground water along the flow path. The extent of potential mixing and the resultant radionuclide concentrations in ground waters at the compliance point is a question that DOE must establish on the basis of its site characterization and modeling activities, and which it will have to defend in the licensing process. As the licensing authority, NRC will have to assess the adequacy of the characterization data and modeling results presented by DOE.

Comment 559 stated that DOE is placing too heavy a reliance on expert elicitation to estimate characteristics of the ground-water flow system, rather than on collecting data from appropriate field testing. The degree to which DOE uses actual site data and expert judgements in its modeling is a decision it must make. EPA believes that expert judgements through expert elicitation processes should not be a substitute for site data that can be collected by a reasonably thorough characterization program. However, we also recognize the value of outside peer review and evaluations as a desirable adjunct to work done within the repository program. The acceptable mix of the two sources of information is a question that DOE and the implementing authority will decide during the licensing process. We believe that our direction embodied in the reasonable expectation approach should supply the context for considering these kinds of decisions.

Issue F: The technical description of the approaches to calculating radionuclide concentrations in the RV for ground water compliance determinations.

1. Clarify the meaning of Table 1 in the standard relative to the inclusion or non-inclusion of background levels for specific radionuclides in the RV. (563)

2. Although we oppose the application of these MCLs to groundwater in general, we find it highly inappropriate to attempt to regulate natural sources of radiation through a standard specifically intended for a high level waste repository at Yucca Mountain. (249)

3. It is appropriate for EPA to give DOE two alternatives for selecting the physical dimensions and orientation of the representative volume (the well capture-zone and slice of the plume methods were proposed). (643)

4. The "slice of the plume" and "well capture-zone" methods for calculating compliance are not adequately explained, and many aspects seem to be arbitrary. We are unsure of the scientific basis for either of these methods or how they would be implemented. (560)

5. The definition of "plume of contamination" under §197.12 states that releases from any other potential sources on or near the Nevada Test Site should not be included in comparisons to the standard. On the one hand, this will allow DOE to be responsible only for the potential releases from Yucca Mountain in meeting the standard. On the other hand, it seems unreasonable to set standards for one activity (i.e., high level radioactive waste disposal at Yucca Mountain) ignoring other nearby potentially significant sources of contamination, such as Pahute Mesa. (564)

6. Assuming there is a separate groundwater standard in the final rule, the dose limits in such standard should be fixed values no more stringent than those specified in Table 1 in §197.35. The dose limits should not be subject to revision before or after promulgation of the standard. (638)

<u>Response to Issue F:</u>

Comments 563 and 249 (1) request clarification regarding whether EPA is requiring the inclusion of background radiation in the representative volume and (2) assert that it is highly inappropriate to include natural sources of radiation in a standard that is intended to regulate releases from radioactive materials stored or disposed of in the repository at Yucca Mountain. Table 1 in Section 197.30 of final 40 CFR part 197 states whether natural background levels of radionuclides are to be included in calculating the ground-water concentrations for comparison against the MCL limits. For the MCL concerning beta and photon emitting radionuclides, which are expected to be the radionuclides that contribute to the potential dose to individuals during the regulatory time period (DOE Viability Assessment, 1998, Docket A-95-12, Item V-A-5), natural background levels are not considered, i.e., the calculations should only consider releases from the repository. The MCL levels for these radionuclides have always been described as man-made radionuclides and therefore background levels should be zero.

EPA's Yucca Mountain standard only applies to radionuclides released from the Yucca Mountain disposal system. At the same time, EPA uses the MCLs as the benchmark to limit the contamination of the representative volume of ground water. The MCLs incorporate provisions that relate to man-made and other [Ra-226 + Ra-228, gross alpha (excluding uranium and radon)] radionuclides. To the extent that these radionuclides are already present in the representative volume of ground water, the allowable releases from Yucca Mountain may be limited so that the radionuclides in the representative volume of ground water do not exceed the MCLs. This is to preserve the quality of the water resource at risk.
Information on the existing levels of radionuclides in ground water in the vicinity of the Yucca Mountain site indicates radionuclide concentrations "well below" the MCLs (see Table 3-19,

Section 3.1.4.2.2 of the Draft Yucca Mountain EIS, Docket A-95-12, Item V-A-4). Further, projected impacts from past, projected and reasonably foreseeable future disposals are estimated at no more than a few percent of that to be expected from the Yucca Mountain repository. This includes a wide variety of activities, the most important of which are the residue from underground testing of nuclear weapons, the disposal of radionuclides at the Greater Confinement Disposal facility, and the shallow land disposal of low-level radioactive waste at the nearby NTS (see Section 8.3.2 of the Draft Yucca Mountain EIS, Docket A-95-12, Item V-A-4).
Based on the existing and projected radionuclide concentrations in ground water in the vicinity of the Yucca Mountain repository, the MCLs will serve as the effective limits to contamination of the representative volume of ground water.

Comments 643 expressed support for EPA's inclusion of two alternatives for selecting the physical dimensions and orientation of the representative volume [Section 197.36(b) of the proposed rule, Section 197.31(b) of the final rule]. Comment 560 asserted that EPA's proposal did not adequately explain these alternatives, that they seem to be arbitrary, and their scientific basis is unclear. EPA proposed two alternative methods ("well capture zone" and "slice of the plume") to allow flexibility for DOE in applying the ground-water protection standard. Whichever of these two methods DOE uses to determine the dimensions of the representative volume, NRC must approve both the method selected and any underlying assumptions used by DOE.

The well capture zone approach is intended to allow a realistic evaluation of contaminant concentrations in contamination plumes intercepting a water supply well that could supply the annual water needs as defined by the representative volume. Specific limitations on certain assumptions that must be incorporated into the well capture zone calculation, e.g., the characteristics of the water supply well, the location of the screened interval, and the pumping rate, were defined to assure that the actual assumptions used in such calculations are consistent with current water uses and practices in the area downgradient from the repository. If this particular method is selected for the ground-water compliance calculations, a case must be made that the assumptions used are reasonable for the area, i.e., the assumptions should not be allowed to produce unrealistic well dilution effects simply for the purpose of demonstrating compliance more easily. To assure that use of this approach can be implemented in a reasonable and scientifically defensible manner, EPA has also clarified the language in § 197.31(b) of the final rule to acknowledge that multiple wells could be used to implement the compliance assessments. A more technically rigorous description of the well capture zone concept is given in Mark Bakker, Otto Strack, *Capture zone delineation in two-dimensional groundwater flow models*, Water Resources Research, 32(5):1309-1315 (1996) (Docket A-95-12, Item V-A-25).

The "slice of the plume" approach takes an alternate perspective in that it is intended for a situation where the contaminant migration is modeled as a broader plume, for example where modeling contaminant migration uses a "stream tube" type of simulation. In reality, the contaminant migration might be any number of individual plumes originating from different portions of the repository, but the modeling approach might use a more generalized approximation and model the migration as a broad plume with characteristics intended to average the behavior of smaller individual contamination plumes. In this approach the representative volume is a "slice of the

plume" taken at the compliance point for calculating average radionuclide concentrations in the "slice." The thickness of the slice is equal to the size of the representative volume (i.e., the amount of aquifer that would hold a water volume equal to the representative volume).
An important decision for this approach is defining where the plume ends, i.e., its three dimensional boundaries, which must be defined so that the contaminant concentrations can be calculated. This must be modeled by DOE, and approved by NRC. Presumably this decision would make use of information on the expected dispersion in the ground-water system downgradient from the site. DOE has conducted one expert elicitation to solicit input on values that should be assumed for downgradient dispersion effects. Information on this subject is difficult to derive through field testing, and we anticipate that external peer review and expert judgements would play a significant part in assessing dispersion effects in the ground-water flow system south of Yucca Mountain.

Comment 564 asserts that it seems unreasonable to set standards for the Yucca Mountain high level radioactive waste repository that "ignor[e]" other nearby potentially significant sources of contamination. The EnPA authorizes EPA to promulgate public health and safety standards for protection of the public from releases of radioactive materials stored or disposed of in Yucca mountain. The EnPA does not authorize EPA to promulgate this public health and safety standard to include releases from the entire NTS or other potentially previously contaminated areas. Moreover, the international radiation protection community has recommended that doses from all practices potentially giving exposures to the population be limited to no more than 100 mrem/yr (International Commission on Radiological Protection - Radiation Protection Principles for the Disposal of Solid Radioactive Waste", ICRP Publication 46, Annals of the ICRP, Vol. 15, No. 4, Pergamon Press, Oxford, UK, Docket A-95-12, Item V-A-12). The maximum dose limit promulgated in this standard is 15 mrem/yr, a number sufficiently below the recommended all sources exposure limit of 100 mrem/yr. This limit allows a significant margin of safety even considering other potential sources of radiation exposure from activities carried on at the NTS.

In addition, current information about the repository's expected performance indicates that the predominant pathway for exposures is through the ground-water system beneath Yucca Mountain and to the south. Current understanding of the ground-water flow systems in the broader area suggests that potential releases from other sources of radionuclide contamination, most importantly underground nuclear weapons detonations, will not mix significantly with releases from the repository [DEIS for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, DOE/EIS - 0250D, Docket A-95-12, Item V-A-4 (the DEIS)]. It appears that contaminant migration from these other activities are located in sub-basins other than Basin 227A where the repository is located, and are not anticipated to contribute to the potential exposure projections for the repository within the regulatory time period (DEIS, Docket A-95-12, Item V-A-4). The majority of underground nuclear tests were conducted in sub-basins to the north and east of Yucca Mountain and the direction of movement of the ground waters in these basins are not all in the direction of Yucca Mountain [Nevada Risk Assessment/Management Program (NRAMP), December 1996, Docket A-95-12, Item V-A-17]. There is significant uncertainty in the understanding of the hydrologic system in the NTS area and the flow rates and accurate projections of the flow patterns in the area are not well established. The potential contaminant migration path for releases from Yucca Mountain are anticipated to be confined to the volcanic and alluvial aquifers downgradient from the site in sub-basin 227A (DEIS, Docket A-95-12, Item V-A-4). DOE has done some extremely conservative assessments of potential exposures from underground testing and estimated a maximum dose at the border of the NTS at 0.22 mrem/yr (DEIS, Section 8.3.2.1.1, Docket A-95-12, Item V-A-4). These assessments assumed the entire inventory of radionuclides from the testing was available for transport and all of it was assumed to move in the direction of projected repository releases. According to current understanding much of the ground water from the testing areas would discharge in areas other than that for Yucca Mountain projected releases. In the event that this understanding changes, the repository exposure limits are sufficiently low that a margin of safety is still likely. One last point on this question, based upon current understanding it would be highly speculative to make projections of scenarios where releases from other NTS activities could mix with potential repository releases. A consistent theme from the NAS recommendations is that regulatory standards and decision making should not be based on highly speculative assessments.

Comment 638 states that the contamination limits for the ground-water protection standard given in table 1 of § 197.35 of the proposed rule should be used for the final rule without the possibility of having these numbers revised to more stringent values. The values referenced correspond to the current MCL concentration limits. Based upon a recent review, EPA has decided to retain the existing MCLs, and these values are included in the final rule for Yucca Mountain (see 65 *FR* 76708-76717, December 7, 2000). The MCLs, like many other regulatory limits, are subject to periodic review to ensure that they are consistent with current scientific knowledge. The MCLs could be re-evaluated for a number of reasons, such as improved understanding of radiation risks for specific radionuclides. In the event that the MCLs are revised, the decision to incorporate such changes into the Yucca Mountain rule would consider whether the changes have any potential impact on the performance assessments for the potential repository site. As stated in § 197.37 of the final rule, EPA may amend the final Yucca Mountain rule, but any such proposed changes would be adopted only through notice-and-comment rulemaking, which gives all concerned parties the opportunity to participate in the process.

Issue G: The estimate of potential population sizes of "several hundred thousand" people to be supplied with drinking water from beneath Yucca Mountain appears highly unlikely.

1. We question the statement in Section III.F that the aquifer which flows beneath Yucca Mountain "theoretically, could supply drinking water for several hundred thousand people." We find that likelihood extremely improbable. (258)

2. The statement that, "It is also a potential source of drinking water for more distant communities and theoretically, could supply drinking water for several hundred thousand people," is in overstatement at best and requires speculation about the unknowable societal futures that are supposed to be assumed similar to those existing today. What is the basis for this statement and a similar statement made in the first paragraph on FR p.47002? The statement in the second

paragraph of FR p.47002, of "hundreds to thousands," is the more reasonable and believable. (583)

Response to Issue G:

EPA believes that the statement in question is not literally incorrect, since drinking water (at ~ 2 liters/day) alone can be supplied to more than hundreds of thousands of people by the perennial yield (4,000 acre-feet/yr, or 4.9 x 10^9 liters) in the basin containing the repository. Nonetheless, EPA recognizes that the total water demands for a population will include higher per capita water use than 2 liters/day, so the number of people that could be supported by the water resources south of the repository is significantly lower than what a simple drinking water only calculation would indicate. Still, the available ground water could satisfy the total demand of a substantial number of persons (a significantly larger population than is now served), making the resource a valuable one for current and future uses.

Issue H: The point of compliance for ground water should be within the Yucca Mountain site, or at the site boundary.

1. The point of compliance should be within or at the site boundary. (5, 483)

2. The point of compliance should be at the site boundary. (24, 179, 208, 292, 336, 430, 451)

3. Given mounting evidence that groundwater has risen and flooded the repository level in the geologic past, EPA should factor in the potential that there may be a large volume of highly contaminated water at the edge of the repository footprint. Moreover, given the uncertainty about future climate, the current availability of water near Yucca Mountain should not constrain the standard setting process for groundwater protection. The MCLs should be determined at the downgradient edge of the repository footprint and not several kilometers away. Modeling considerations based on low water volume available today should not be a principal factor in decision-making on the withdrawal point for the water. (293)

4. I think that the boundary should be closer rather than farther away from the repository. And in fact, I would question whether it should be at the door of the repository versus the 3 miles or 5 kilometers. (135)

Response to Issue H:

EPA rejected suggestions that it locate the point of compliance either within (comments 5, 483), or at the site boundary (comments 24, 135, 179, 208, 292, 293, 336, 430, 451) because we believe that this approach is unnecessarily conservative. In reaching this decision, we acknowledge the approach employed in our generally applicable standard for the land disposal of spent nuclear fuel, high-level, and TRU waste at 40 CFR part 191. The controlled area concept established in 40 CFR part 191 links a 5 km distance from the repository footprint (the area in which the waste is disposed) to a limit on the size of the controlled area (100 km^2). Within the controlled area, compliance calculations related to ground-water protection would not apply on the basis that the geology surrounding the waste within this controlled area comprises an essential part of the total disposal system. Locating the point of compliance within the site boundary or at the site boundary would reverse this long-standing concept of geological disposal. As a generally applicable standard, 40 CFR part 191 necessarily had to incorporate flexibility in defining where the rule applies. Note that in the 1980s, when 40 CFR part 191 was developed, DOE was considering a total of 9 candidate repository sites. For a generic standard, this combination of controlled area and approach to protecting ground water is appropriate. It is able to account for the wide variety of site configurations, engineered alternatives, and population characteristics that may be encountered. We are implementing 40 CFR part 191 in the ongoing certification process for WIPP TRU repository in New Mexico.

By contrast, 40 CFR part 197 is a site-specific public health standard mandated under a new authority, the Energy Policy Act of 1992. With the 1987 amendment of the Nuclear Waste Policy Act, the Yucca Mountain site has been under an intense site characterization effort. EPA has a significant amount of information regarding past, present, and planned population patterns, land use, engineered design, and the hydrogeological characteristics of the host rock. We also have the recommendations of the NAS Yucca Mountain panel, which advises the use of present day knowledge and cautious but reasonable assumptions to define who is protected (NAS Report, p. 100). Given the wealth of site-specific information related to ground-water flow and present and planned population patterns in the vicinity of the Yucca Mountain site, we have sought to develop a protective point of compliance related to the ground-water resources near Yucca Mountain. Our final selection reflects present knowledge and where necessary, cautious but reasonable assumptions, related to the use of ground-water resources at Yucca Mountain. Also, as explained above, we have adopted the concept of a controlled area for Yucca Mountain as an essential precondition to assessing compliance with the ground-water standards.

None of the information EPA has reviewed suggests it likely or reasonable that year-round residents will locate at or within the site boundary of the proposed repository. As discussed in Chapter 8 (Section 8.2.3.2) and Appendix IV of the BID, it would be extremely difficult to farm that close to Yucca Mountain, partly because of poor soil conditions and because extracting ground water at that location would be technically challenging and prohibitively expensive for an individual or small group. In addition, much of this area has rough terrain and soils not conducive to farming. Our understanding of projections of future land use do not indicate significant population growth much farther north of Lathrop Wells (see Appendix I, BID). Given present and planned population patterns and the extreme difficulty in accessing ground water at or within the site boundary, we think it unreasonable that a year-round resident will locate there. Therefore, we have not chosen a point of compliance at or within the site boundary for the site-specific standards at Yucca Mountain.

One comment (293) supported the point of compliance at the edge of the repository footprint based upon geological evidence that ground-water levels have risen and flooded the repository in the geologic past. Present understanding of the Yucca Mountain site does not support a flooded repository. In addition, the present climate regime and its effects on the Yucca Mountain repository are expected to persist for most of the 10,000-year regulatory period. Finally, the selection of the compliance point for purposes of ground-water protection relies upon present knowledge and cautious but reasonable assumptions, as suggested by NAS. These points are addressed in more detail below.

The impact of climate change, including the possibility that the repository might be flooded by a rise in the ground water, was considered in the NAS Report (pp. 91-92). Accordingly, NAS concluded:

> "There is a reasonable data base from which to infer past changes in the water table at Yucca Mountain. Although past increases under wetter climates are evidenced, a water-table rise to the point that the repository would be flooded appears unlikely."

Although it does not appear that the repository would be flooded, variations in climate may still affect subsurface hydrology. The NAS noted that the subsurface location of the repository provides a natural "temporal filter" for climate change effects on hydrologic processes. This delay in unsaturated zone flux changes at the repository "is probably in the range of hundreds to thousands of years. The time required for saturated flow-system responses is probably even longer. For this reason...the effects of climate change on the deep hydrogeology can be assessed over much longer time scales" (NAS Report, p. 92).

In evaluating the impact of climate change on projected repository performance, DOE has developed three different cyclic climate regimes to describe conditions that exist at Yucca Mountain. Current conditions fall within a dry pattern and are expected to last between the next 5,000 and 10,000 years. Beyond that are "long term average" conditions, which are expected to persist for about 90,000 years, and "superpluvial" conditions, which are expected to persist for about 10,000 years. Precipitation rates for the latter two climate regimes are estimated at 2X and 3X, respectively, higher than current precipitation levels (see Chapter 3, DOE/VA, Docket A-95-12, Item V-A-5, and Chapter 7 of the BID, Docket A-95-12, Item V-B-1). Given the current understanding of the climate regime at Yucca Mountain and the delay in climate change effects on the repository (identified by NAS above) due to its depth below the surface, it would appear extremely unlikely that climate change would cause significant changes in the ground water quality or accessibility in the vicinity of the Yucca Mountain repository within the 10,000- year regulatory period. Further, should DOE select any design enhancements presently under consideration [such as a more robust containers and/or drip shields (see Section 2.1.4 of the DOE DEIS, Docket A-95-12, Item V-A-4)], expected releases from the repository may begin much later, perhaps beyond the regulatory period.

Finally, the intent of EPA's ground-water protection standard is to protect the ground-water resource near Yucca Mountain. The NAS advised using present knowledge and cautious but reasonable assumptions to describe the exposure scenarios to be used in performance assessment (NAS Report, p. 100). We believe it similarly appropriate to use present knowledge and cautious, but reasonable, assumptions in determining potential ground water usage. EPA has used this approach in defining where the ground-water resource might be accessed, considering such factors as depth to ground water, present and potential access points for ground water usage, the types of activities supported by the ground water resource, and the characteristics of the local land and terrain as far as suitability for agricultural pursuits or residential development (see the responses to Issues H and I herein, and Section III.B.4.f of the preamble, "Where Will Compliance With the Ground Water Standards be Assessed?"). As explained above, when these factors are considered, we did not select the repository footprint as a point of compliance for the Yucca Mountain repository.

Issue I: Other alternatives for ground water point of compliance beyond the site boundary

1. The point of compliance should be at or less than 1 km from the site boundary. (442)

2. The point of compliance for ground water should be at 5 km (Alternative 1). (56, 84, 85, 308, 343, 498)

3. The point of compliance for ground water should be at 20 km (Alternative 2). (175, 565)

4. The point of compliance for ground water should be closer than 30 km. (85,137)

5. The point of compliance for ground water should be at 30 km (Alternative 3). (217, 640)

6. The point of compliance for ground water should be no closer than the RMEI (proposed at 20 km, corresponding to Alternative 2). (175, 238, 773)

7. None of the proposed points of compliance offers sufficient protection. (410)

8. 5 km is too close for ground water compliance, and 18 or 20 km are indistinguishable. (562)

9. The proposed alternatives for ground water compliance are not reflective of the resource. (599)

10. Technical Edit: Revise preamble to reflect available data regarding ground water flow from Yucca Mountain to the town of Amargosa Valley. (657)

Response to Issue I:

A number of comments suggested that EPA locate the point of compliance at varying distances from the repository footprint, ranging from less than 1 km to 30 km. One commenter suggested that the proposed alternative points of compliance are not reflective of the resource. One comment suggested that we revise the preamble to reflect available data regarding ground-water flow away from the repository. As discussed above, we chose to retain the concept of a controlled area, limited to no more than 300 km^2, while limiting its extent in any direction to 5 kilometers, except that in the direction of ground water migration, the controlled area may extend no farther than any point on a line described by 36 degrees, 40 minutes, 13.6661 seconds north latitude. This latter distance is roughly 18 km from the repository footprint.

One comment supported a compliance point less than 1 km from the site boundary (442). Numerous comments supported a compliance point at 5 km from the site boundary, partly as a matter of consistency with our generic standards at 40 CFR part 191 (Comments 56, 84, 308, 343, 498). As indicated above in the Response to Issue H, we acknowledge this approach and find it particularly well-suited for a generally applicable standard. The present rule, however, is mandated by EPA's new authority under the Energy Policy Act of 1992 and calls for a site-specific public health and safety standard for Yucca Mountain. According to Section 801(a)(1) of this Act, our standards are to be "based upon and consistent with" the findings and recommendations of the Yucca Mountain NAS panel. We have considerable site-specific information and the recommendations of the Yucca Mountain NAS panel, which advised using present knowledge and cautious but reasonable assumptions to define who is protected. None of the information we have reviewed suggests it likely or reasonable that year-round residents will locate at or within the site boundary of the proposed repository. We believe this is also true at a distance of 5 km from the site boundary. Placing the point of compliance at 5 km violates our requirement that assumptions on future states not be overly speculative. We believe that the point of compliance should reflect current land use, or reasonable projections of future land use, in terms of the volume of water used and its location. As discussed in Chapter 8 of the BID, it would be extremely difficult to farm that close to Yucca Mountain, partly because of poor soil conditions (Section 8.2.3.3 of BID) and because extracting ground water at that location would be technically challenging and prohibitively expensive for an individual or small group (Section 8.2.3.2 of BID). Our understanding of projections of future land use do not indicate significant population growth much farther north of Lathrop Wells (see Appendix I, BID), which is approximately 20 km distant, although there are plans for development between Lathrop Wells and the NTS boundary (Docket A-95-12, Items V-A-14, 15, 16, 19). Given present and planned population patterns and the extreme difficulty in accessing ground water at 5 km, we think it unreasonable that a year-round resident will locate there. Therefore, we have not chosen a point of compliance at points less than 5 km from the repository footprint for the site-specific standards at Yucca Mountain.

As one goes farther away from Yucca Mountain in the direction of ground water flow, it is easier to drill for ground water as the water table is closer to the ground surface. Additionally, the soil characteristics improve such that agricultural pursuits become more feasible and this is evidenced by the considerable agricultural activity in the Amargosa Valley some 30 km from Yucca Mountain, which was suggested as a compliance point by a few comments (217, 640). However, to select a distance of 30 km would ignore farming that occurs as close as 23 km (Chapter 8, BID). Also, much greater dilution of the affected ground water occurs at 30 km and existing uses of ground water closer than 30 km would not be adequately protected. For these reasons, EPA did not select 30 km as the compliance point for ground-water protection purposes.

Distances approximating 20 km appear more reasonable to consider. Two commenters recommended the 20 km distance (comments 175, 565) and two thought it should be no closer than the 20 km distance applicable to the RMEI (comments 238, 773). EPA has decided to require compliance with the ground-water and individual-protection standards at the same location, i.e., in the accessible environment where the highest concentration in the plume of contamination is located. This distance can be no farther south than the southern boundary of

NTS (about 18 km from the repository footprint). We believe that the RMEI could use the same ground-water resources for domestic and agricultural practices and hence be exposed to a greater number of exposure pathways. Since the RMEI may be exposed to a greater number of pathways, some of which may not be due to direct ingestion of ground water, the individual-protection standard will be used to judge the acceptability of the RMEI exposures.

According to Chapter 8 of the BID, no farming occurs closer than about 23 km south of the proposed repository footprint. There are approximately ten residents at 20 km and hundreds of persons at a distance of 30 km. Current projections of population growth indicate increases in the area of the 20 and 30 km distances. Although one comment (562) portrayed the 18 and 20 km distances as indistinguishable, we believe there are merits to limiting the maximum distance in the direction of ground-water flow to less than 20 km. We have adopted a controlled area, limited to 300 km^2, that may extend no farther in the direction of ground-water flow than the distance from the repository footprint to any point on a line described by 36 degrees, 40 minutes, 13.6661 seconds north latitude. The southwesternmost corner of the NTS and its southern boundary correspond to this latitude designation (Docket A-95-12, Item V-A-29), which is roughly 18 km from the repository footprint. It is expected that some population growth may occur north of the 20 km location, Lathrop Wells. This would be a small group of residents who could use ground water for domestic and some limited agricultural purposes. As shown in Appendix III of the BID, the same gravelly, sandy loam that supports agriculture between 20 and 30 km from Yucca Mountain also extends north of Lathrop Wells to the NTS boundary at 18 km. A distance of 18 km provides a degree of conservatism, as compared to a 20 km location, in that the expected concentrations of radionuclides in the representative volume of ground water would be slightly higher at 18 km. At distances closer than 18 km, the depth to the water table increases dramatically, as shown by Table 8-5 and Figure 8-9 in the BID. While it becomes more difficult to drill for water, soil conditions also become less favorable for agriculture. Also, access to NTS is restricted by the Federal government. We believe, based upon the site-specific information now available, and using cautious, but reasonable, assumptions, that a point on a line described by 36 degrees, 40 minutes, 13.6661 seconds north latitude would be the closest location for a small group of individuals to be accessing the ground-water resources near Yucca Mountain and is, therefore, protective of the ground-water resources reasonably anticipated in the vicinity of the Yucca Mountain repository. Again, DOE and NRC must determines where the highest concentrations of radionuclides in the accessible environment will occur, and assess compliance at that location. This is to assure that the compliance point for ground water is positioned to be certain that the analyses take into account the highest concentration in the accessible environment and will be cautiously, but reasonably, conservative in nature.

Finally, one comment (657) indicated that the description of the ground water system beneath the site was not accurate and should be revised to reflect information published in the DOE Viability Assessment document and supporting information. We have revised the preamble and the supporting Background Information Document to reflect the most current information available about the ground water flow system around the repository.